Amendment
U.S. Patent Application No. 10/762,249

Amendments to the Claims:

This listing of claims will replace all prior versions, and listings, of claims in the application.

Listing of Claims:

1. (Currently Amended) A method of forming ~~an antenna~~ a transmit antenna beam with a phased array antenna comprising an array of antenna elements, the method comprising:

selecting a plurality of angular directions at which nulls are to be located in an antenna ~~radiation~~ transmission pattern of the phased array antenna;

computing a radiation shaping transformation as a function of the selected angular directions by constructing a plurality of vectors corresponding to the selected angular directions at which the nulls are to be located and computing a matrix whose product with each of the vectors is zero; and

determining from the radiation shaping transformation an amplitude and phase distribution over the array of antenna elements that forms the transmit antenna beam with nulls of the antenna ~~radiation~~ transmission pattern at the selected angular directions, wherein the amplitude and phase distribution is determined from the matrix.

2. (Canceled)

3. (Currently Amended) The method of claim 1 ~~claim 2~~, wherein the phased array antenna comprises M antenna elements, k angular directions are selected at which nulls are to be located, and the matrix is an MxM matrix of rank M-k.

4. (Currently Amended) The method of claim 1, further comprising:

applying amplitude tapering to the phased array antenna to reduce sidelobe levels of the antenna ~~radiation~~ transmission pattern relative to a uniform illumination ~~radiation~~ transmission pattern.

5. (Currently Amended) The method of claim 4, wherein the amplitude and phase distribution determined from the radiation shaping transformation reduces a width of a main lobe of the antenna ~~beam~~ transmission pattern relative to the width of the main lobe resulting from amplitude tapering without the amplitude and phase distribution determined from the radiation shaping transformation.

6. (Currently Amended) The method of claim 4, wherein the amplitude and phase distribution determined from the radiation shaping transformation increases main lobe power of the antenna ~~beam~~ transmission pattern relative to the main lobe power resulting from amplitude tapering without the amplitude and phase distribution determined from the radiation shaping transformation.

7. (Currently Amended) The method of claim 4, wherein the amplitude and phase distribution determined from the radiation shaping transformation reduces sidelobe levels of the antenna ~~radiation~~ transmission pattern relative to sidelobe levels resulting from amplitude tapering without the amplitude and phase distribution determined from the radiation shaping transformation.

8. (Currently Amended) The method of claim 1, wherein the amplitude and phase distribution determined from the radiation shaping transformation reduces sidelobe levels of the antenna ~~radiation~~ transmission pattern relative to a uniform illumination ~~radiation~~ transmission pattern.

9. (Currently Amended) The method of claim 1, wherein the amplitude and phase distribution determined from the radiation shaping transformation increases main lobe power of the antenna ~~beam~~ transmission pattern relative to a uniform illumination ~~radiation~~ transmission pattern.

10-11. (Canceled)

12. (Original) The method of claim 1, wherein computing a radiation shaping transformation includes performing a Gram-Schmidt orthogonalization procedure.

13. (Currently Amended) A method of forming ~~an antenna~~ a transmit antenna beam with a phased array antenna comprising an array of antenna elements, the method comprising:

selecting a plurality of angular directions at which nulls are to be located in an antenna ~~radiation~~ transmission pattern of the phased array antenna;

constructing a plurality of vectors corresponding to selected antenna radiation pattern nulls;

computing a matrix whose product with each of the vectors is zero; and

determining from the matrix an amplitude and phase distribution over the array of antenna elements that forms the antenna beam with nulls of the antenna ~~radiation~~ transmission pattern at the selected angular directions.

14. (Currently Amended) A method of forming ~~an antenna~~ a transmit antenna beam with a phased array antenna comprising M antenna elements, the method comprising:

selecting k angular directions at which nulls are to be located in an antenna ~~radiation~~ transmission pattern of the phased array antenna;

constructing k vectors v_n corresponding to selected antenna ~~radiation~~ transmission pattern nulls;

computing an MxM matrix A of rank M-k that satisfies $Av_n = 0$ for $n = 1, \ldots, k$;

determining from matrix A an amplitude and phase distribution over the array of antenna elements that forms the transmit antenna beam with nulls at the selected angular directions.

15. (Currently Amended) An apparatus for forming ~~an antenna~~ a transmit antenna beam,

comprising:

a phased array antenna comprising an array of antenna elements;

a processor that computes a radiation shaping transformation by constructing a plurality of vectors corresponding to ~~as a function of~~ selected angular directions at which nulls are to be located in an antenna ~~radiation~~ transmission pattern of the phased array antenna and computing a matrix whose product with each of the vectors is zero; and

an antenna element control module that controls amplitudes and phases of the antenna elements in accordance with the radiation shaping transformation to produce an amplitude and phase distribution over the array of antenna elements that forms the transmit antenna beam with nulls of the antenna ~~radiation~~ transmission pattern at the selected angular directions, wherein the amplitude and phase distribution is determined from the matrix.

16. (Original) The apparatus of claim 15, wherein the antenna element control module comprises a plurality of phase control elements and amplitude control elements respectively corresponding to the antenna elements.

17. (Original) The apparatus of claim 16, wherein the amplitude control elements are variable attenuators.

18. (Original) The apparatus of claim 16, wherein the amplitude control elements are variable amplifiers.

19. (Original) The apparatus of claim 16, wherein the amplitude control elements are linear amplifiers.

20. (Original) The apparatus of claim 16, wherein the amplitude control elements are saturated amplifiers.

21. (Original) The apparatus of claim 16, wherein the phase control elements are variable phase shifters.

22. (Canceled)

23. (Currently Amended) The apparatus of claim 15 ~~claim 22~~, wherein the phased array antenna comprises M antenna elements, k angular directions are selected at which nulls are to be located, and the matrix is an MxM matrix of rank M-k.

24. (Currently Amended) The apparatus of claim 15, wherein the antenna element control module applies amplitude tapering to the phased array antenna to reduce sidelobe levels of the antenna ~~radiation~~ transmission pattern relative to a uniform illumination ~~radiation~~ transmission pattern.

25. (Currently Amended) The apparatus of claim 24, wherein the amplitude and phase distribution determined from the radiation shaping transformation reduces a width of a main lobe of the antenna ~~beam~~ transmission pattern relative to the width of the main lobe resulting from amplitude tapering without the radiation shaping transformation.

26. (Currently Amended) The apparatus of claim 24, wherein the amplitude and phase distribution determined from the radiation shaping transformation increases main lobe power of the antenna ~~beam~~ transmission pattern relative to the main lobe power resulting from amplitude tapering without the radiation shaping transformation.

27. (Currently Amended) The apparatus of claim 24, wherein the amplitude and phase distribution determined from the radiation shaping transformation reduces sidelobe levels of the antenna ~~radiation~~ transmission pattern relative to sidelobe levels resulting from amplitude tapering without the radiation shaping transformation.

28. (Currently Amended) The apparatus of claim 15, wherein the amplitude and phase distribution determined from the radiation shaping transformation reduces sidelobe levels of the antenna ~~radiation~~ transmission pattern relative to a uniform illumination ~~radiation~~ transmission pattern.

29. (Currently Amended) The apparatus of claim 15, wherein the amplitude and phase distribution determined from the radiation shaping transformation increases main lobe power of the antenna ~~beam~~ transmission pattern relative to a uniform illumination ~~radiation~~ transmission pattern.

30. (Original) The apparatus of claim 15, further comprising a transmitter module that generates signals to be transmitted by the phased array antenna, wherein the phased array antenna transmits via the antenna beam the signals generated by the transmitter module.

31. (Canceled)

32. (Currently Amended) The ~~method~~ apparatus of ~~claim 1~~ claim 15, wherein, in computing the radiation shaping transformation, the processor performs a Gram-Schmidt orthogonalization procedure.

33. (Currently Amended) An apparatus for forming ~~an antenna~~ a transmit antenna beam, comprising:

a phased array antenna comprising an array of antenna elements;

means for computing a radiation shaping transformation by constructing a plurality of vectors corresponding to ~~as a function of~~ selected angular directions at which nulls are to be located in an antenna ~~radiation~~ transmission pattern of the phased array antenna and computing a matrix whose product with each of the vectors is zero; and

means for controlling amplitudes and phases of the antenna elements in accordance with the radiation shaping transformation to produce an amplitude and phase distribution over the array of antenna elements that forms the transmit antenna beam with nulls of the antenna ~~radiation~~ transmission pattern at the selected angular directions, wherein the amplitude and phase distribution is determined from the matrix.

34. (Canceled)